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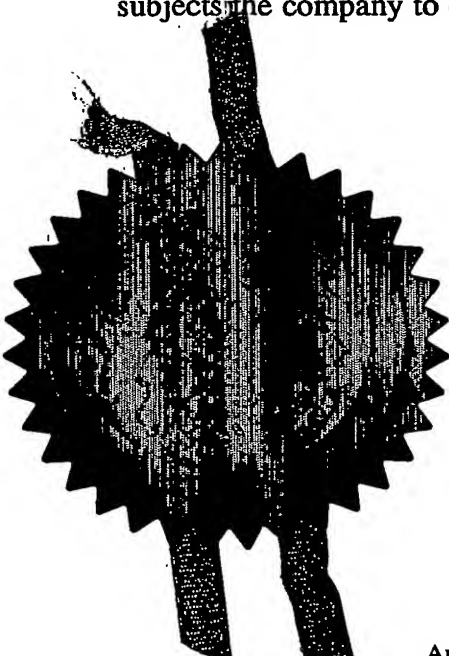
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1. Your reference 31 OCT 2002 2153-P8013-GB

2. Patent application number 0225315.1 NEW

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Patents ADP number (*if you know it*)

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4. Title of the invention Mechanically Operable Electrical Device

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Patents ADP number

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6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (<i>if you know it</i>) the or each application number	Country	Priority application number (<i>if you know it</i>)	Date of filing (<i>day/month/year</i>)
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Description

19

Claim(s)

05

Abstract

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I/We request the grant of a patent on the basis of this application.

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Date Wednesday, 30 October 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

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Mechanically Operable Electrical Device

Background of the Invention

1. Field of the Invention

5 The present invention relates to a mechanically operable electrical device. In particular, such a device comprising a transmitter electrode, a receiver electrode and a moveable conductive element.

2. Description of the Related Art

10 Electrical switches comprising of a pair of electrodes which are brought into contact to complete a circuit are well known. A potential problem with some such switches is that repetitive use causes mechanical wear of the electrodes and consequent failure.

15 In addition, code reading devices are known such that when a coded card to be read is inserted, conductive patches of the card electrically connect selected electrodes of the device to complete electrical circuits. However, due to abrasion by the connecting electrodes, the conductive patches may become worn and lead to incorrect reading of the code.

20 Brief Summary of the Invention

25 According to a first aspect of the present invention, there is provided a mechanically operable electrical device, comprising a transmitter electrode, a receiver electrode and a moveable conductive element, wherein: said device is configured such that said conductive element is moveable to a first position remote from said electrodes such that said transmitter electrode is capacitance coupled to said receiver electrode; and said

conductive element is moveable to a second position closer to said electrodes such that said capacitance coupling is reduced.

Brief Description of the Several Views of the Drawings

5 *Figure 1* shows an electrical appliance 101 embodying the present invention;

Figure 2 shows an exploded perspective view of components of the linear array of button switches 101;

10 *Figures 3A and 3B* show a front and rear view of the PCB 206 respectively;

Figures 4A and 4B illustrates the operation of the button switch 102;

Figure 5 shows a diagram of a circuit used to determine the status of the button switches 102 to 105;

15 *Figure 6* shows signals which illustrate the operation of the circuit of *Figure 5*;

Figure 7 shows an exploded perspective view of components of the rotary switching device 106;

Figures 8A and 8B show front and rear views respectively of the PCB 704;

20 *Figure 9* show an alternative rotary switching device 900;

Figure 10 shows an electronic apparatus 1001 and a card 1002 used with the apparatus 1001;

Figure 11 shows the code reader 1008 and the card 1002 of *Figure 10*;

25 *Figures 12 and 13* show the facing surfaces of the printed circuit boards 1120 and 1121 respectively;

Figures 14A and 14B show cross-sectional views of capacitor devices of card reader 1008 which illustrate their operation;

Figure 15 shows a diagram of the electronic circuitry 1501 of card reader 1008; and

Figure 16 shows an alternative card reading arrangement for the toy 1001.

Written Description of the Best Mode for Carrying Out the Invention

Figure 1

An electrical appliance 101 embodying the present invention is shown in *Figure 1*. The appliance 100 has a linear array 101 of four manually operable push button switches 102, 103, 104 and 105 which allow a user to select functions of the appliance. In addition, the appliance 101 has a rotary switching device 106 which may be manually rotated to one of five positions to allow a further optional selection to be made.

Figure 2

An exploded perspective view of components of the linear array of button switches 101 is shown in *Figure 2*. Each of the four switches 102 to 105 in the array comprises of a button portion, 202, 203, 204 and 205 respectively. The button portions are configured to be depressed by finger pressure, and they are subject to spring mechanisms (not shown) which return them to their original positions after being pressed and released. The buttons may also be subject to a mechanism which maintains their position after depression, until they are re-pressed. Such mechanisms are known in the art.

The button portions 202 to 204 are manufactured from an electrically insulating material such as a plastics material. An electrically grounded (earthed) conductive element, made from a rectangular piece of metal, is rigidly attached to the rear side of each button portion. Thus, for example, conductive portion 201 is rigidly attached to the rear surface of button portion 202.

The linear array 101 of button switches also contains a printed circuit board (PCB) 206, which defines a capacitor device 212, 213, 214, and 215 for each of the button switches 102 to 105 respectively.

When the button portions are not depressed, the conductive portion 201 is located remotely from the corresponding capacitor device 212. For example, it may be positioned ten millimetres away. Upon depression of the button portion, the conductive element 201 is relocated to a position relatively near to the capacitor device 212, for example two millimetres away. The consequential electrical effects on said capacitor device are detected as will be described below.

The conductive element 201 is never brought into contact with electrodes of the capacitor device 212. To ensure this contact does not take place, the conductive element and/or the electrodes of the capacitor device are covered with an insulating layer, for example, a plastic layer or coating. Alternatively, the movement of the button portion may be mechanically limited to ensure the conductive element cannot make contact upon the PCB.

In an alternative embodiment, the PCB 206 is replaced with a plastic membrane supporting conductive material, such as a conductive ink, defining the capacitance devices and the corresponding tracks providing electrical connections to said devices.

It should be understood that although switch array 101 has been described by way of example to have four button switches, other switch arrays embodying the present invention may be produced with more or less than four such switches. Thus, in the simplest case, the switch array comprises a single button switch.

Figures 3A and 3B

A front and rear view of the PCB 206 is provided by *Figures 3A and 3B* respectively.

The capacitor devices 212 to 215 each comprise of a transmitter electrode 302, 303, 304 and 305 respectively and a receiver electrode 312, 313, 314, 315 respectively. Each transmitter electrode takes the form of an open circular element which is concentric with a smaller circular element defining the corresponding receiver electrode. Tracks 322 to 325 on the front surface of the PCB provide individual electrical connection to corresponding transmitter electrodes 302 to 305 respectively. The receiving electrodes 312 to 315 are connected to a common track 301 on the rear of the PCB 206 via plated through holes in the PCB. One end of the track 301 terminates in a region 350 of the PCB which supports electronic circuitry for processing signals received by the receiving electrodes.

Hatched areas 351 and 352 on the front and rear of the PCB are electrically grounded. In addition, conductive circular arcs 332 to 335 are arranged concentrically around the capacitor devices 212 to 215 respectively on the front surface of the PCB, and conductive circular arcs 342 to 345 are arranged concentrically around the receiving electrodes 312 to 315 respectively on the rear surface of the PCB. The arcs 342 to 345 and 332 to

335 are also electrically grounded.

The close proximity of the electrically grounded elements 342 to 345 and 332 to 335 ensures that spurious signals received at the receiving electrodes caused by external radiation are kept to within tolerable limits.

5

Figures 4A and 4B

The operation of the button switch 102 is illustrated in *Figures 4A* and *4B*.

10 The button switch 102 is shown in the non-pressed configuration in *Figure 4A*. Consequently, the gap between conductive element 201 and the capacitor device 212 is large compared to the relatively small gap of *Figure 4B* where the switch is shown depressed.

15 During operation of the appliance 101, a series of square electrical pulses are applied to the transmitter electrode 302 and the resulting signal received at receiving electrode 312 is analysed to determine whether the button switch 102 is depressed or not.

20 When the moveable conductive element 201 is remote from the device 212, as shown in *Figure 4A*, the close proximity of the transmitter electrode 302 and the receiver electrode 312 provides sufficient capacitance coupling between said electrodes to allow the signal received at the receiver electrode to be detected. In contrast, when the moveable conductive element 201 is close to the device 212, as shown in *Figure 4B*, the closeness of said conductive element reduces the capacitance coupling between the transmitter and receiver electrodes such that the received signal is
25 significantly reduced in amplitude.

Example lines of electrical flux 401 and 402, established during the application of the square pulse to the transmitter electrode 302, are illustrated in *Figure 4A* and *4B* respectively. The flux lines 401 illustrate how an electric field is generated between the transmitter electrode 302 and receiver electrode 312, when the button switch is not depressed. Whereas, when it is depressed, the close proximity of the conductive element 201 modifies the electric field such that the flux 402 between the transmitter electrode 302 and the conductive element 201 is increased and that between the transmitter electrode and receiving electrode 312 is correspondingly decreased.

Figure 5

A diagram of a circuit used to determine the status of the button switches 102 to 105 is shown in *Figure 5*. Each of the transmitter electrodes 302 to 305 is connected to a respective low impedance output port OP1, OP2, OP3 and OP4 of a micro-controller 501. The micro-controller operates under instructions received from read only memory (ROM) 502. The ROM 502 and the controller 501 may be part of a single application specific integrated circuit (ASIC). The micro-controller is also in communication with an additional memory device, in the form of an EPROM (erasable programmable read only memory) 503, which may be a plug-in device allowing the operation of the micro-controller to be modified.

The receiving electrodes 312 to 315 of the capacitor devices 212 to 215 are all connected together to the input of analysing electronic circuitry 504. The circuitry 504 comprises of an amplifier 505, a bandpass filter 506 configured to filter the output of said amplifier, and a comparator 507, which takes the output of said filter as its input. The output from the comparator is

connected to an input port, IP1, of the micro-controller 501.

The micro-controller 501 also has four output ports connected to drive circuitry 508 which generates drive signals in response to the output signals received from the micro-controller. The drive signals may energise actuators, heaters, lights etc. (not shown) in accordance with the type and function of the appliance 101.

Figure 6

Signals illustrating the operation of the circuit of Figure 5 are shown in Figure 6.

As illustrated by graphs 601 to 604, the controller 501 sequentially outputs, to the transmitter electrodes 302 to 305, a square pulse 611 via output port OP1, a square pulse 612 via output port OP2, a square pulse 613 via output port OP3, and then a square pulse 614 via output port OP4. The sequence is then repeatedly repeated.

An example signal received at the receiving electrodes is shown in graph 605 after amplification and filtering by amplifier 505 and filter 506. The square pulse applied to a transmitter electrode causes charge flow to and from the corresponding receiver electrode. Thus each square pulse generates a positive going pulse 615 to 618 and a negative going pulse 625 to 628 respectively at a receiver electrode.

The filtered signal received at the comparator 507 is compared with a threshold voltage. When the filtered signal is above the threshold voltage a high voltage is supplied to the micro-controller input, and when the filtered signal is below the threshold voltage a low (zero) voltage supplied to the micro-controller input. The graph 606 therefore illustrates the signal received

at the input IP1 from the comparator output.

In the present example, it has been assumed that only button switch 104 has been depressed. Consequently, positive going pulse 617 is below the threshold voltage while the other similar pulses 615, 616 and 618 are above it. In response, the comparator outputs square pulses 635, 636 and 638 while the comparator input is above the threshold voltage. It may be noted that, due to the finite rise time of the pulses 615, 616 and 618, there is a delay between leading edge of the square pulses 611, 612 and 614 and the corresponding leading edge of the square pulses 635, 636 and 638.

Following the output of a square pulse to one of the transmitter electrodes 302 to 305, the micro-controller monitors the signal level at the input port IP1 for a subsequent predefined period to determine whether the corresponding switch is depressed. For example, following the output of pulse 611 to switch 102, the pulse 635 received at input port IP1, indicates to the micro-controller that the button switch 102 is not depressed. Whereas, following the output of pulse 613 the voltage on input port IP1 remains low in the subsequent period and thus the micro-controller determines that the button switch 104 is depressed.

Figure 7.

An exploded perspective view of components of the rotary switching device 106 is shown in *Figure 7*. A circular disc 701 is rigidly attached to the manually operable part of the rotary switching device such that it is rotatable about its central axis. The disc 701 has a base made from an insulating material with an electrically grounded conductive region 702 on one of its sides. The disc may thus be made in the manner of a printed circuit board.

The conductive region 702 has a circular portion 703 located off-centre so that as the disc is rotated the portion 703 rotates about the disc's axis.

5 The side supporting the conductive region 702 is parallel to and closely spaced from a printed circuit board (PCB) 704 such that they share a common central axis. The PCB 704 contains five capacitor devices 711, 712, 713, 714 and 715, and it is rigidly mounted within the appliance 101. Consequently, as the disc 701 is rotated it rotates with respect to the PCB 704, and the conductive portion 703 may be located over each of the five capacitor devices in turn. Preferably, the rotary switching device 106 contains
10 a ratchet mechanism (not shown) so that, when the rotary switching device is rotated and released, the conductive portion 703 is brought to rest directly over a capacitor device.

Figure 8

15 The PCB 704 is shown in greater detail in the front and rear views of Figures 8A and 8B respectively. Each of the five capacitor devices 711 to 715 have a similar structure to the capacitor devices on PCB 206. Thus, capacitor device 711 has a small circular receiver electrode 812 surrounded by a transmitter electrode 802. The transmitter electrode 802 is itself
20 surrounded by an electrically grounded ground electrode 832. The receiver electrodes of each capacitor device are all connected to a single track 801 via plated through holes in the PCB 704 and tracks 808 on its rear surface.

The rear surface of the PCB 704 has arc shaped ground electrodes 842, 843, 844, 845 and 846, which are concentric with the capacitor devices
25 711 to 715 respectively.

As shown in *Figure 8A*, the transmitter electrodes such as electrode 802 form the greater part of a circle but a gap in the circle allows for an extended portion 809 of the ground electrodes, such as electrode 832, to extend inwards towards the transmitter electrodes, such as 812. The extended portion of the ground electrodes has a form and position which corresponds to a section of the tracks 808 on the rear side and thus provides additional shielding for the receiver electrodes.

The effect of the conductive region 703 (shown in *Figure 7*) on the capacitor devices 711 to 715 is the same as that of the conductive element 201 on capacitor device 212. Thus, for example, when the conductive region 703 is rotated to a position which is remote from the capacitor device 711, the capacitance coupling between the transmitter electrode 802 and the receiver electrode 812 is relatively high and allows a signal applied to the transmitter electrode to be received at the receiver electrode, and, when the conductive region is rotated to a position which is adjacent to said capacitor device, the capacitance coupling is reduced thereby reducing the amplitude of the received signal.

The rotary switching device 106 is incorporated into a similar circuit to that shown in *Figure 5*, whereby a manual selection, made by rotating the conductive region 703 over a particular one of the capacitor devices 711 to 715, is received.

In an alternative embodiment, a linear switch array, similar to that shown in *Figure 2*, and a rotary switching device, similar to that shown in *Figure 7*, share a single PCB. Thus the features of PBC 206 and PCB 704 are produced on a single PCB. Advantageously, the receiving electrodes of the switch array and the rotary switching device are connected together.

Consequently, the same analysing electronic circuitry and micro-controller may be used to determine selections made at the switch array and the rotary switching device.

5 **Figure 9**

10 An alternative rotary switching device 900 is shown in *Figure 9*. The device 900 uses the same PCB 704 as device 106. However, the rotatable disc 701 is replaced with an insulating board or sheet 901 which has a fixed location close to, and parallel to, the PCB 704. For example, in this embodiment the PCB 704 and insulating sheet 901 are separated by 1mm. The sheet 901 is made from a plastics material but in alternative embodiments is made from paper or card. The sheet 901 has five circular regions 902, 903, 904, 905, 906 on its side facing away from the PCB 704, that are coated with a conducting material. The conductive material may be a
15 conductive ink, such as a carbon ink, a silver ink or transparent conductive ink, or a conductive paint etc. The positions of the conductive regions 902 to 906 correspond to those of the five capacitor devices 711 to 715, so that they overlay said capacitor devices.

20 In common with device 106, device 900 has a rotatable handle 907 allowing manual selection by its rotation. A sprung electrically grounded electrode 908 is rigidly attached to the handle 907. The ground electrode 908 has smooth connecting portion 909 which presses against the sheet 901 and which may be brought into contact with any one of the five conducting regions 902 to 906 by rotation of the handle 907.

25 During operation, the capacitance coupling between the transmitter electrodes and receiver electrodes of each of the capacitor devices 711 to

715 may be reduced by rotating the ground electrode 908 to a position where it electrically grounds the corresponding conductive region 902 to 906 respectively.

5 **Figure 10**

An electronic apparatus 1001 and a card 1002 used with the apparatus 1001 is shown in *Figure 10*. In this instance, the electronic apparatus 1001 is an educational toy for a child.

10 To use the toy 1001 a card such as the card 1002 is inserted into a slot 1003 in said toy. When it is fully inserted, an image 1009 on the card is viewable through a transparent window 1010 in the upper face of the toy. The toy 1001 is provided with an internal spring loaded arm (not shown) which maintains the position of the card within the slot 1003 while it is being used.

15 After pressing an "ON" button 1004 a child is able to interact with the toy by indicating selected regions of the card 1002 using a stylus 1005. This is achieved by receiving signals at an electrical receiver located in the stylus tip 1006 that are transmitted by a matrix of linear electrodes within the toy 1001. Devices having such position detection means are known in the art.

20 The card 1002 is one of many cards which may be used in co-operation with the toy 1001. Therefore, in order to operate correctly, the identity of the card 1002 must be provided to the toy 1001. For this reason, the card 1002 has an identifying code 1007 arranged along an end portion of the card, and the toy 1001 has code reader 1008. The code reader 1008 receives the end portion of an inserted card and identifies it from the
25 identifying code 1007.

The toy 1001 and card 1002 provide an example of the present invention. However, it should be understood that other portable objects supporting code defined by conductive elements may be used with code reading apparatus operating in accordance with the present invention. For example, the code reading apparatus may form part of a security device, such as a door lock, requiring the insertion of a card having a particular code in order to be activated.

Figure 11

The code reader 1008 and the card 1002 of *Figure 10* are shown in *Figure 11*. The identifying code 1007 comprises of a series of conductive pads linearly arranged adjacent the edge 1101 of the card 1002. Cards, such as card 1002, have eight regions 1111 to 1118 inclusive, reserved for the possible application of a conductive pad. One or more of the conductive pads are applied to the card as conductive ink, or paint, during their production. Preferably, the card is subsequently laminated or coated with an insulating protective layer of, for example, a plastics material. (The protective layer 1400 is shown in *Figures 14A* and *14B*). Thus the ink is protected from abrasion during use.

The cards, such as card 1002, are individually identifiable by the presence or absence of conductive ink in each of the reserved regions 1111 to 1118. For example, the pattern of the conductive pads may be considered to define a binary code number which identifies the card. For example, card 1002 has a conductive pad at regions 1111, 1113, 1116, 1117 and 1118 while regions 1112, 1114 and 1115 are devoid of conductive material. Thus, the conductive pads on card 1002 define the binary number 10100111, or

167 in base ten. In this way, using eight reserved regions and at least one conductive pad on each card, two hundred and fifty-five different cards may be identified. Alternatively, the cards may have different images on each of their faces so that they may be used either way up. In this case, each face of the card is identified by the identifying code 1007. For example, if card 1002 were turned up side down and edge 1101 inserted into card reader 1008, it would present the binary number 11100101 (two hundred and twenty-nine in base ten) to the card reader. i.e. the reverse of binary number 10100111. Thus, the two faces of the card are individually represented by a single identifying code.

The card reader 1008 comprises of two printed circuit boards 1120 and 1121 spaced apart by spacers 1122. The gap between the PCB 1120 and the PCB 1121 is sufficiently wide to provide a loose fit for the end portion of cards, such as card 1002. Typically, the gap is between two millimetres to five millimetres wide, and preferably it is two millimetres to three millimetres wide. The upper surface 1123 of PCB 1120 is conductive and electrically grounded to provide shielding for receiver electrodes located on its lower surface.

Transmitter electrodes are located on the upper surface of the PCB 1121, and in combination with the receiver electrodes they define eight capacitor devices. Each capacitor device is positioned to receive one of the reserved regions 1111 to 1118 when a card is inserted. The reduction of conductance coupling in one of said capacitor devices, caused by the presence of a conductive pad, allows the card reader 1008 to determine its presence.

Figures 12 and 13

The facing surfaces of the printed circuit boards 1120 and 1121 are shown in *Figures 12 and 13* respectively. PCB 1120 has eight circular receiver electrodes 1201 to 1208 inclusive, which are linearly aligned and equally spaced. The PCB also supports signal analysing circuitry within a region 1210, and all the receiving electrodes 1201 to 1208 are connected to said circuitry by a single conductive track 1209. A grounded electrode 1211 (shown hatched) surrounds the receiving electrodes 1201 to 1208 and the conductive track 1209, to provide further shielding for the receiving electrodes from electromagnetic noise.

As shown in *Figure 13*, the upper surface of PCB 1121 has eight square shaped transmitter electrodes 1301 to 1308 inclusive. The eight transmitter electrodes are positioned such that they face the receiver electrodes 1201 to 1208 when the card reader 1123 is assembled. The transmitter electrodes are connected to terminals 1309 by plated through holes in their centres and conductive tracks on the reverse side of the PCB 1121 (illustrated by dashed lines 1310). A ground electrode 1311 surrounds the transmitter electrodes to provide further screening from electromagnetic noise.

Figure 14A and 14B

The operation of capacitor devices of card reader 1008 is illustrated in the cross-sectional views of *Figures 14A and 14B*. *Figure 14A* shows the capacitor device defined by transmitting electrode 1302 and receiving electrode 1202 while reading card 1002. In operation, a square pulse is

applied to the transmitter electrode 1302 via a conductive track 1310. In the absence of a conductive pad, the capacitance coupling between said electrodes remains relatively high, and consequently a relatively high signal is received at receiving electrode 1202.

5 *Figure 14B* shows the capacitor device defined by transmitting electrode 1303 and receiving electrode 1203 while reading the same card, 1002. In this instance, a conductive pad 1401 is present between said electrodes and, consequently, the capacitance coupling between them is reduced to a relatively low value. Therefore, when a square pulse is applied
10 to the transmitter electrode 1303, the presence of the conductive pad 1401 causes a relatively low signal to be received at receiving electrode 1203.

Thus, by supplying a square pulse to each of the transmitting electrodes 1301 to 1308 in turn, and monitoring the amplitude of the pulse received at receiving electrodes, it is possible to determine the identifying
15 code on the currently inserted card.

Figure 15

A diagram of the electronic circuitry 1501 of card reader 1008 is shown in *Figure 15*. Many of the components of circuit 1500 are the same as
20 those of *Figure 5* and operate in a similar manner. Thus, circuit 1500 has a micro-controller 1501, in communication with a ROM 1502 and an EPROM 1503. The EPROM 1503 may be configured to be replaceable, so that a particular EPROM which is designed for use with a particular set of cards may be used.

25 The micro-controller 1501 also receives digital signals from analysing electronic circuitry 1504, itself comprising an amplifier 1505, a bandpass filter

1506 configured to filter the output of said amplifier, and a comparator 1507.

Eight output ports of the micro-controller 1501 are each connected to one of the transmitter electrodes 1301 to 1308. The receiving electrode 1201 to 1208 are all connected to a single input of amplifier 1505.

5 A ninth output port of micro-controller 1501 is connected to amplifier 1510 which provides signals to an audio speaker 1511. Thus, in response to the identification of a card, signals relating to the card are supplied to the amplifier 1501 in accordance with data stored in EPROM 1503.

10 The operation of the circuit 1500 is essentially the same as the circuit of Figure 5. Thus, the micro-controller 1501 supplies a square pulse to each transmitter electrode 1301 to 1308 in turn, and in a following period, it monitors the signal received from comparator 1507. Signals received by receiving electrodes are amplified by amplifier 1505 before being filtered by bandpass filter 1506. The comparator 1507 determines whether the signal
15 goes above a threshold value, and if so then a high output is supplied to microprocessor 1501. Consequently, the micro-controller is able to determine the presence or absence of a conductive pad in each of the regions 1111 to 1118 of a card, and thus determine the identity of said card.

20 *Figure 16*

An alternative card reading arrangement for the toy 1001 is illustrated by Figure 16. A PCB 1601 has essentially the same structure as PCB 1120 except that it contains ten receiving electrodes, instead of eight. However, unlike the card reader 1008, the corresponding transmitting electrodes 1603
25 are printed onto a flexible plastic membrane 1602. As well as forming a part of the card reading arrangement, the plastic membrane supports the matrix

of linear conductors which are used in co-operation with the stylus 1006 to provide an X-Y position sensing device.

Thus when a card is initially inserted, or the toy is first switched on, signals are supplied via the linear conductors to the transmitter electrodes to identify the card. Having identified the card the matrix is then used in the position sensing mode.

In a further alternative card reading arrangement for the toy 1001, the PCB 1601 is replaced with an extended portion of plastic membrane 1602. Receiving electrodes are printed onto the extended portion, and the membrane is folded such that each of the receiving electrodes is positioned opposite one of the transmitting electrodes 1603. The membrane is folded such that a suitable gap is provided between the receiving electrodes and transmitting electrodes for receiving a card such as card 1002. This alternative arrangement operates in the same manner as those of *Figure 10*, or *Figure 16*, but has the advantage of not requiring a PCB to provide the transmitting and receiving electrodes.

The receiving electrodes and transmitting electrodes are separated by a gap produced by the folding.

Claims

1. A mechanically operable electrical device, comprising a transmitter electrode, a receiver electrode and a moveable conductive element, wherein:

said device is configured such that said conductive element is moveable to a first position remote from said electrodes such that said transmitter electrode is capacitance coupled to said receiver electrode; and

said conductive element is moveable to a second position closer to said electrodes such that said capacitance coupling is reduced.

2. A mechanically operable electrical device according to claim 1, wherein said device comprises a ground electrode which is grounded in use to electromagnetically shield said receiving electrode.

3. A mechanically operable electrical device according to claim 1 or claim 2, wherein said conductive element is continuously grounded during use.

4. A mechanically operable electrical device according to any of claims 1 to 3, wherein said transmitter electrode and said receiver electrode are located in the same plane.

5. A mechanically operable electrical device according to any of claims 1 or 2, wherein said conductive element is not electrically connected.

6. A mechanically operable electrical device according to any of claims 1 to 3 or claim 5, wherein said receiving electrode is positioned on a separate parallel plane to said transmitting electrode.

5

7. A mechanically operable electrical device according to any of claims 1 to 3 or claim 5 or 6, wherein said conductive element in said second position is located between said transmitter electrode and said receiver electrode.

10

8. A mechanically operable electrical device according to any of claims 1 to 7 wherein said transmitter electrode is formed on a printed circuit board.

15

9. A mechanically operable electrical device according to claim 8, wherein said printed circuit board is a membrane which forms part of a position sensing device.

20

10. A mechanically operable electrical device according to any of claims 1 to 9, wherein said transmitter electrode and receiver electrode are one of a plurality of such pairs of transmitter electrodes and corresponding receiver electrodes; said conductive element is one of a number of conductive elements located on a portable object to define an identifying code; and said portable object is configured to be manually inserted between said transmitter electrodes and said receiver electrodes, whereby the capacitance coupling between each transmitting electrode and the

25

corresponding receiver electrode depends upon the presence of a conductive element on said portable object.

5 11. A mechanically operable electrical device according to any of claims 1 to 4, wherein said device is configured as a manually operable switch.

10 12. A mechanically operable electrical device according to claim 11, wherein said device further comprises one or more additional pairs of transmitter electrodes and receiver electrodes, and said conductive element is moveable by rotation to other positions in which it is closer to one of said pairs of electrodes.

15 13. Code reading apparatus, and a coded object having one or more conductive regions at defined locations to define a code, wherein said device comprises:

 a plurality of capacitor devices each having a transmitter electrode and a capacitance coupled receiver electrode;

20 a signal generating device configured to supply a signal of a predetermined type to each said transmitter electrode; and

 a signal analysing means for analysing a received signal received by said receiving electrodes,

25 wherein said code reading device is configured to receive said one or more conductive regions of said coded object such that the capacitance coupling between the electrodes of one or more corresponding capacitor devices is modified, whereby the signal received at one or more

corresponding receiving electrodes is modified.

14. Code reading apparatus according to claim 13, wherein said coded object is a card.

5

15. Code reading apparatus according to claim 13 or claim 14, wherein said code reading apparatus is a toy and said coded object is one of a plurality of coded cards, each card being individually identified by conductive regions defining a code.

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16. Code reading apparatus according to claim 15, wherein said card has images on each of its faces, and said apparatus is configured to identify the displayed face from said code.

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17. Code reading apparatus according to claim 13 or claim 14, wherein said code reading apparatus forms part of security apparatus.

20

18. A mechanically operable electrical device, comprising a transmitter electrode; a receiver electrode capacitance coupled to said transmitter electrode; a conductive element adjacent to said transmitter electrode and said receiver electrode; and a ground electrode, wherein

said ground electrode is moveable between:

(a) a first position in which said conductive element is not electrically grounded such that capacitance coupling between said transmitter electrode and said receiver electrode is relatively high; and

25

(b) a second position in which said conductive element is electrically grounded whereby said capacitance coupling is reduced.

1/15

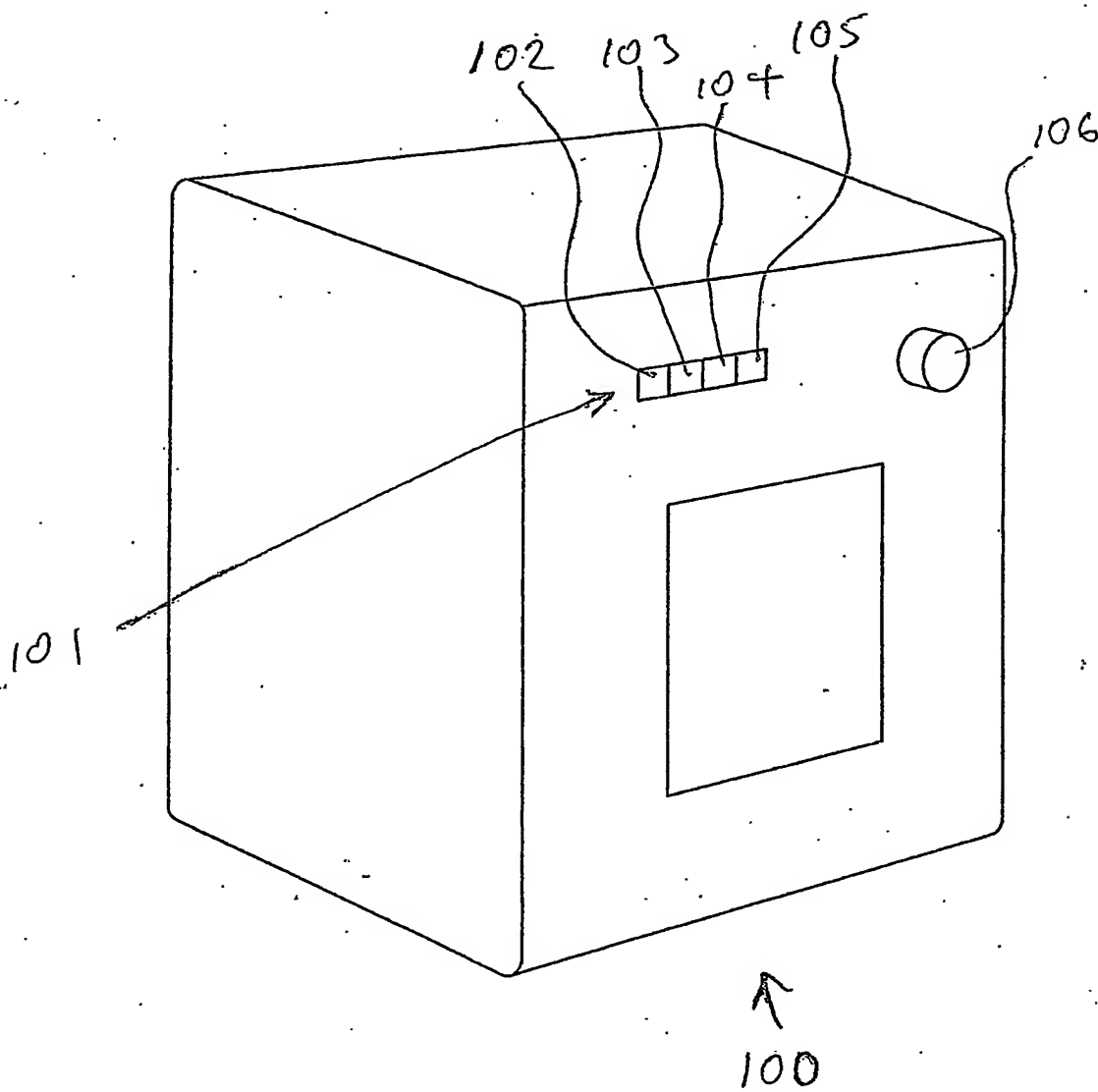


Fig. 1

2/15

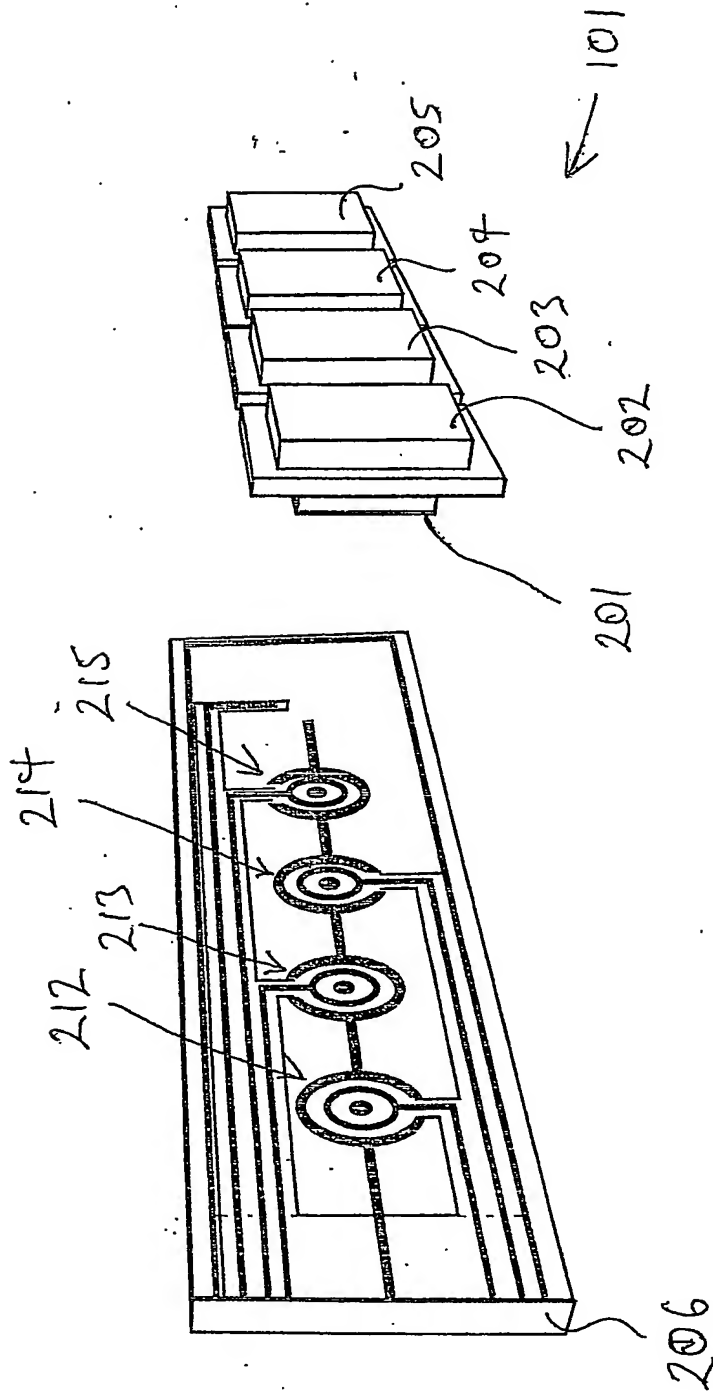


Fig. 2

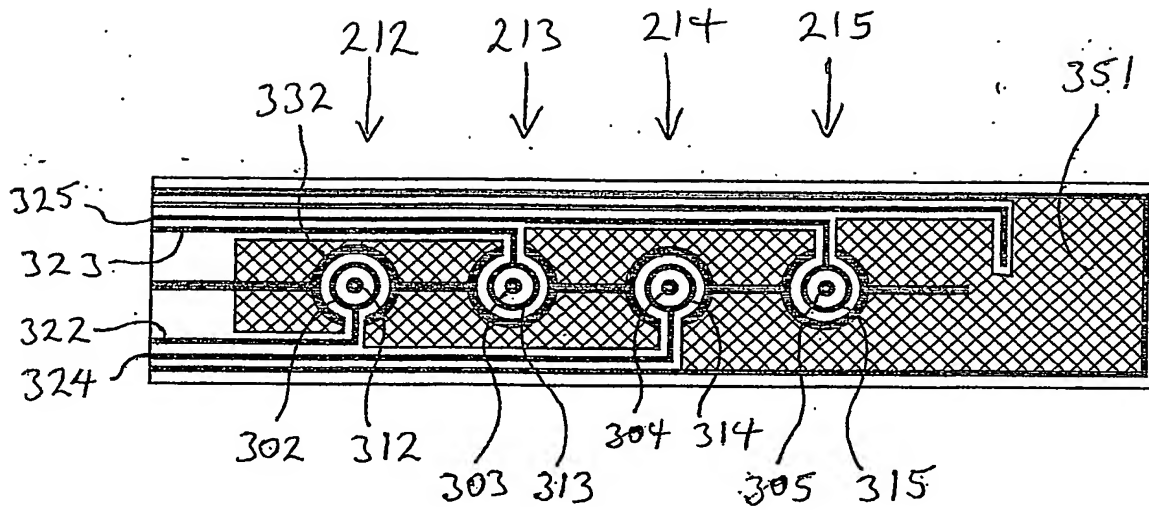


Fig. 3A

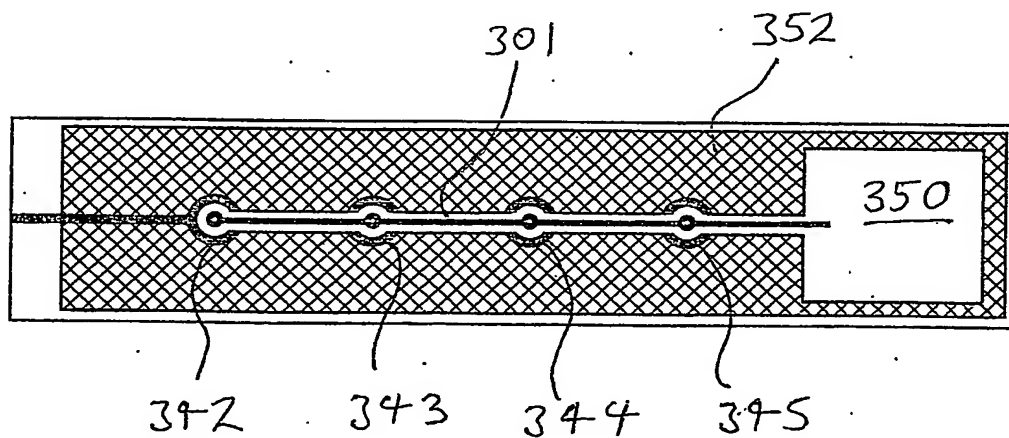


Fig. 3B

4/15

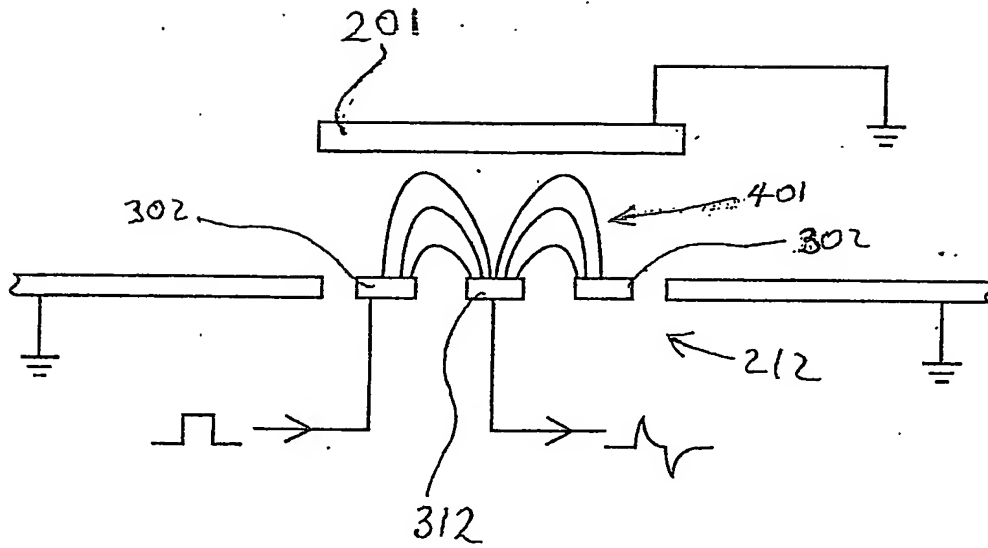


Fig. 4A

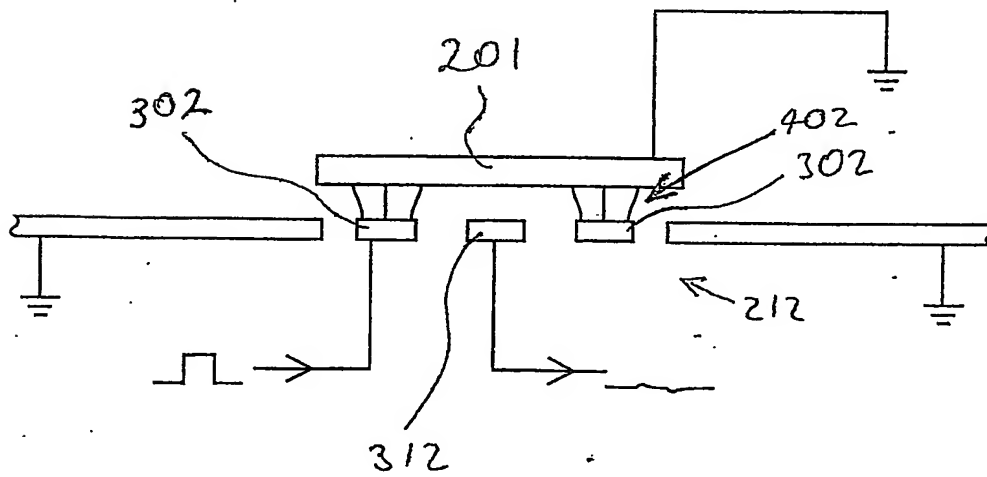


Fig. 4B

5/15

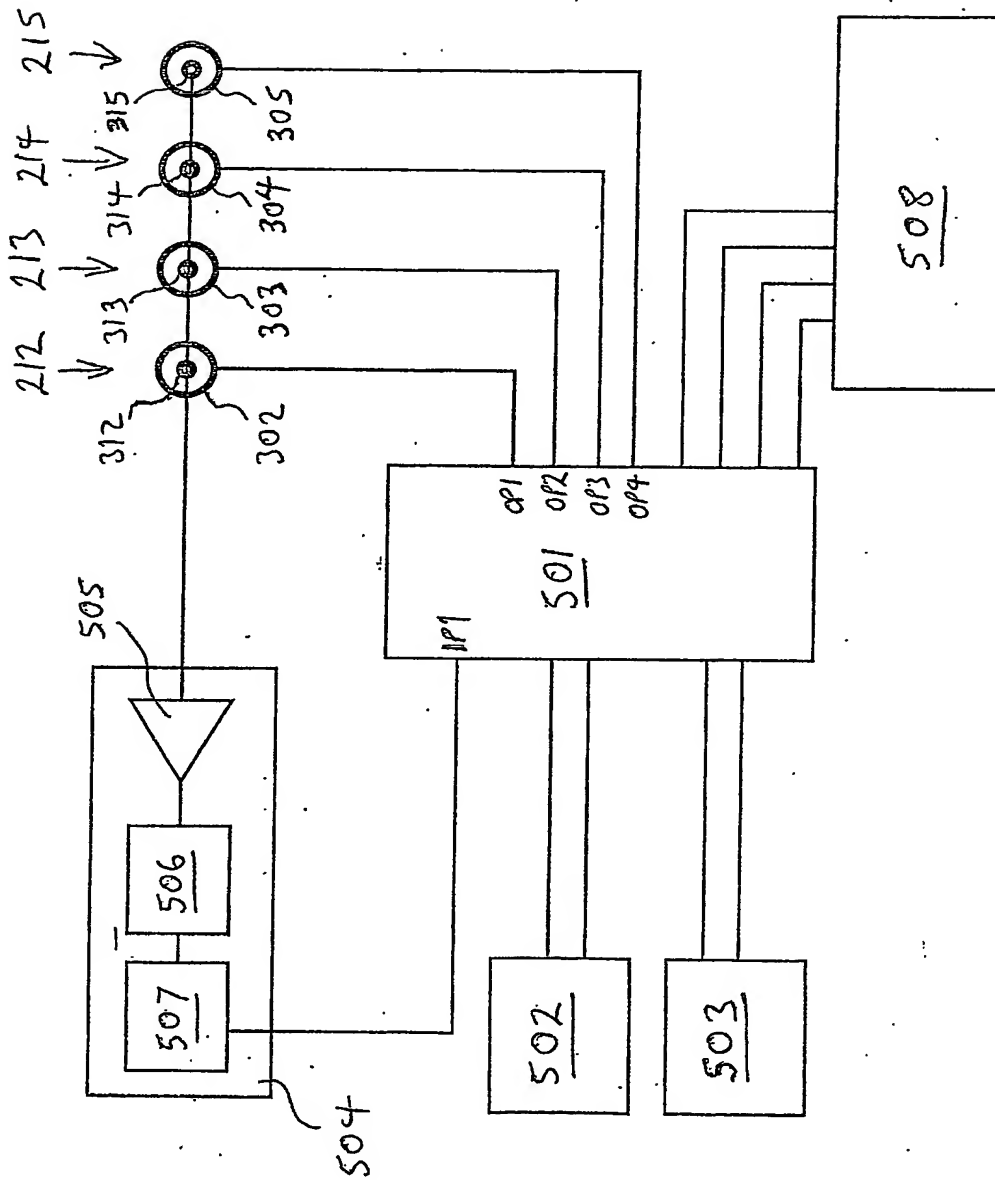


Fig. 5

6/15

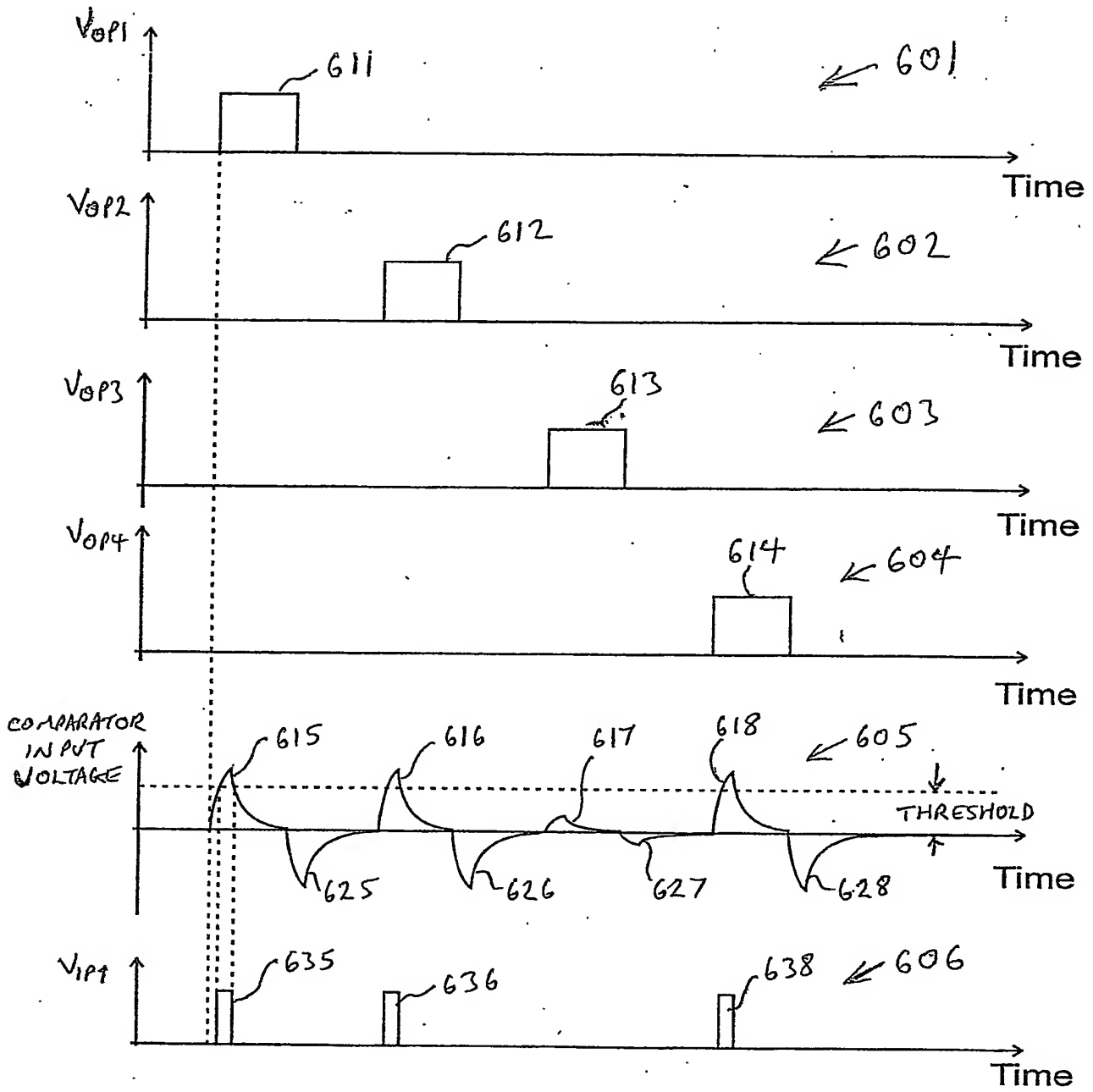


Fig. 6

7/15

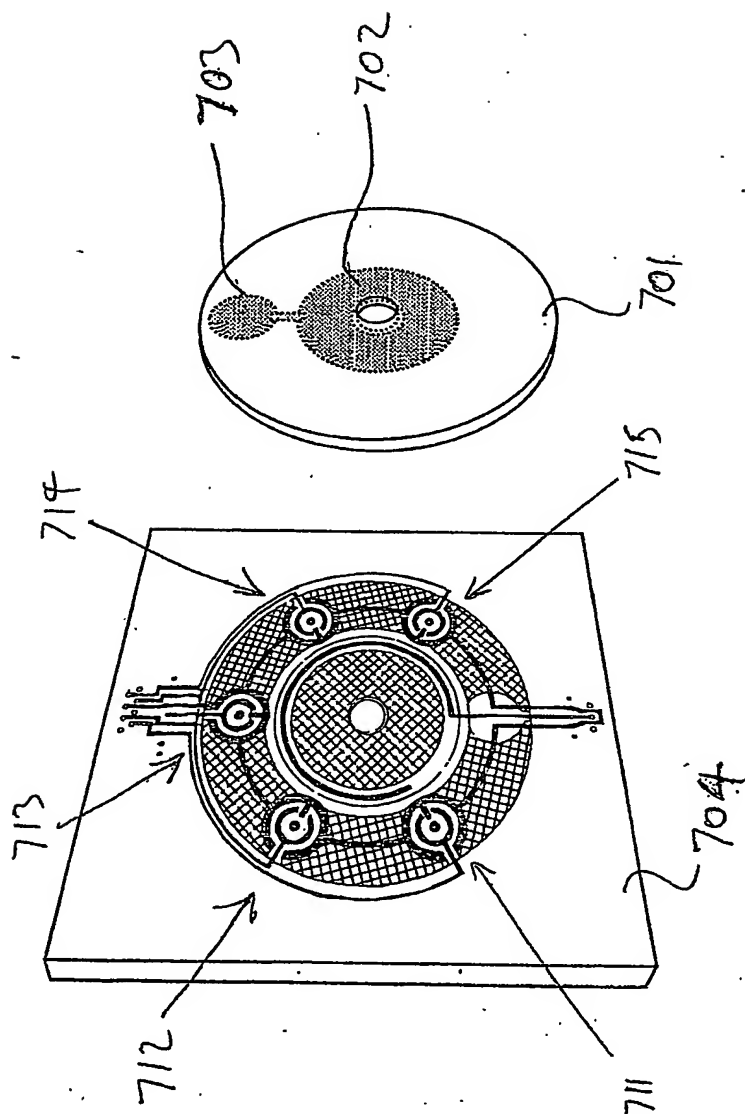


Fig. 7

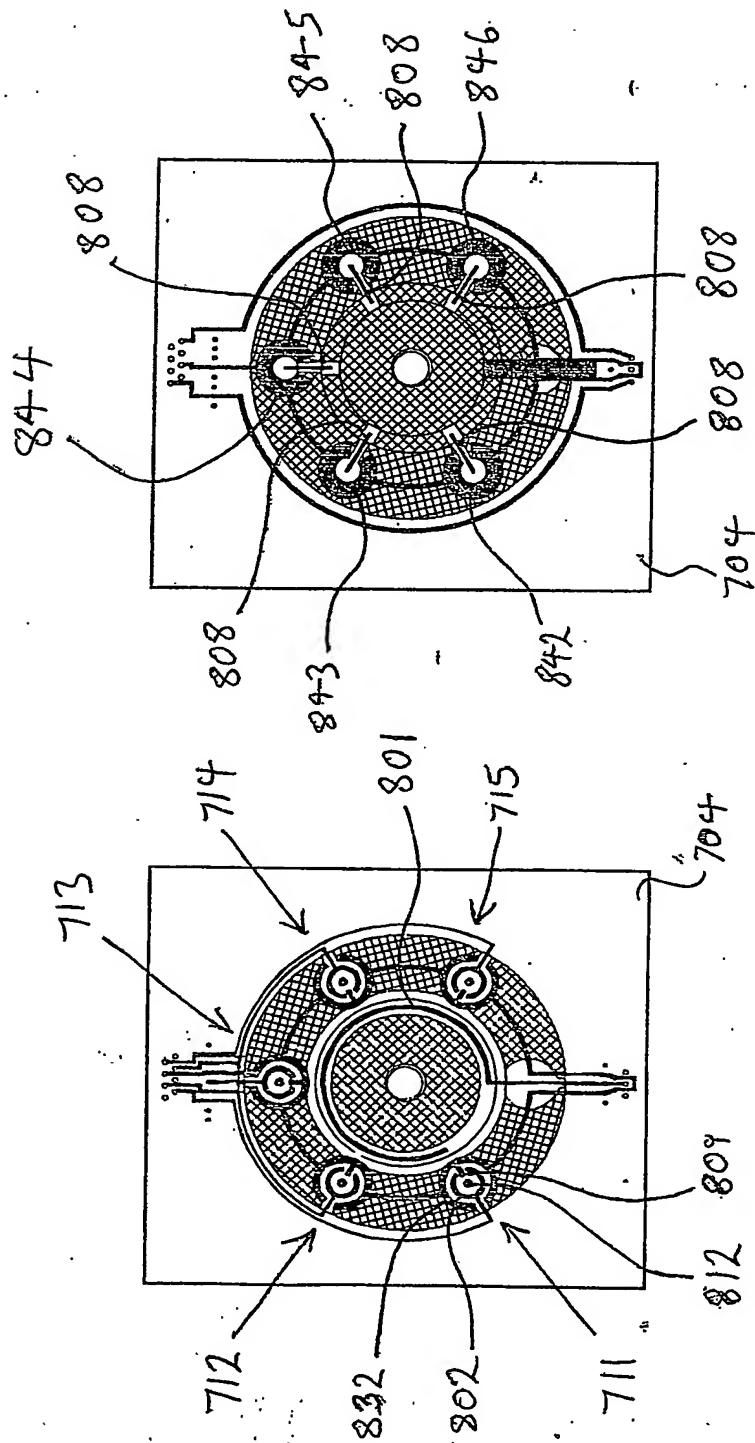


Fig. 8A

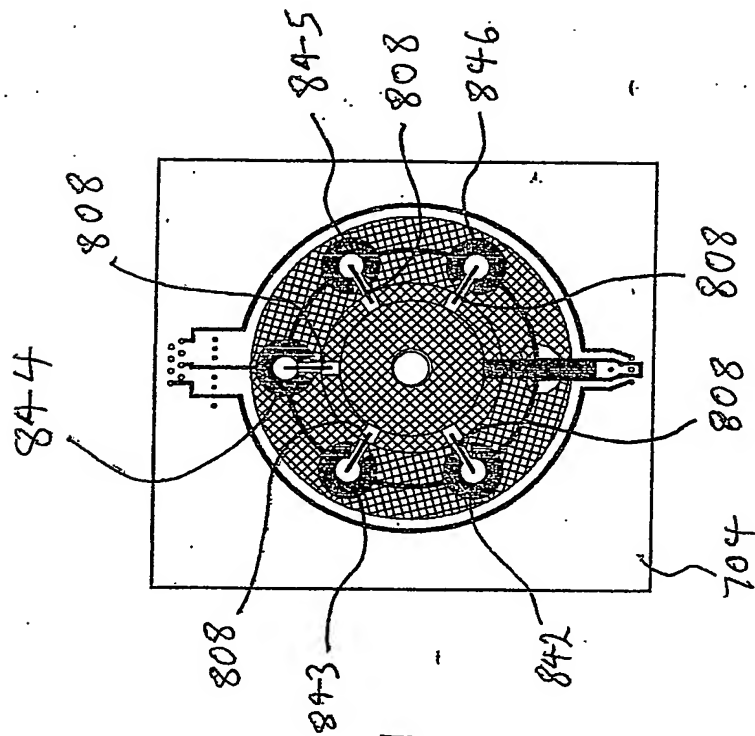


Fig. 8B

9/15

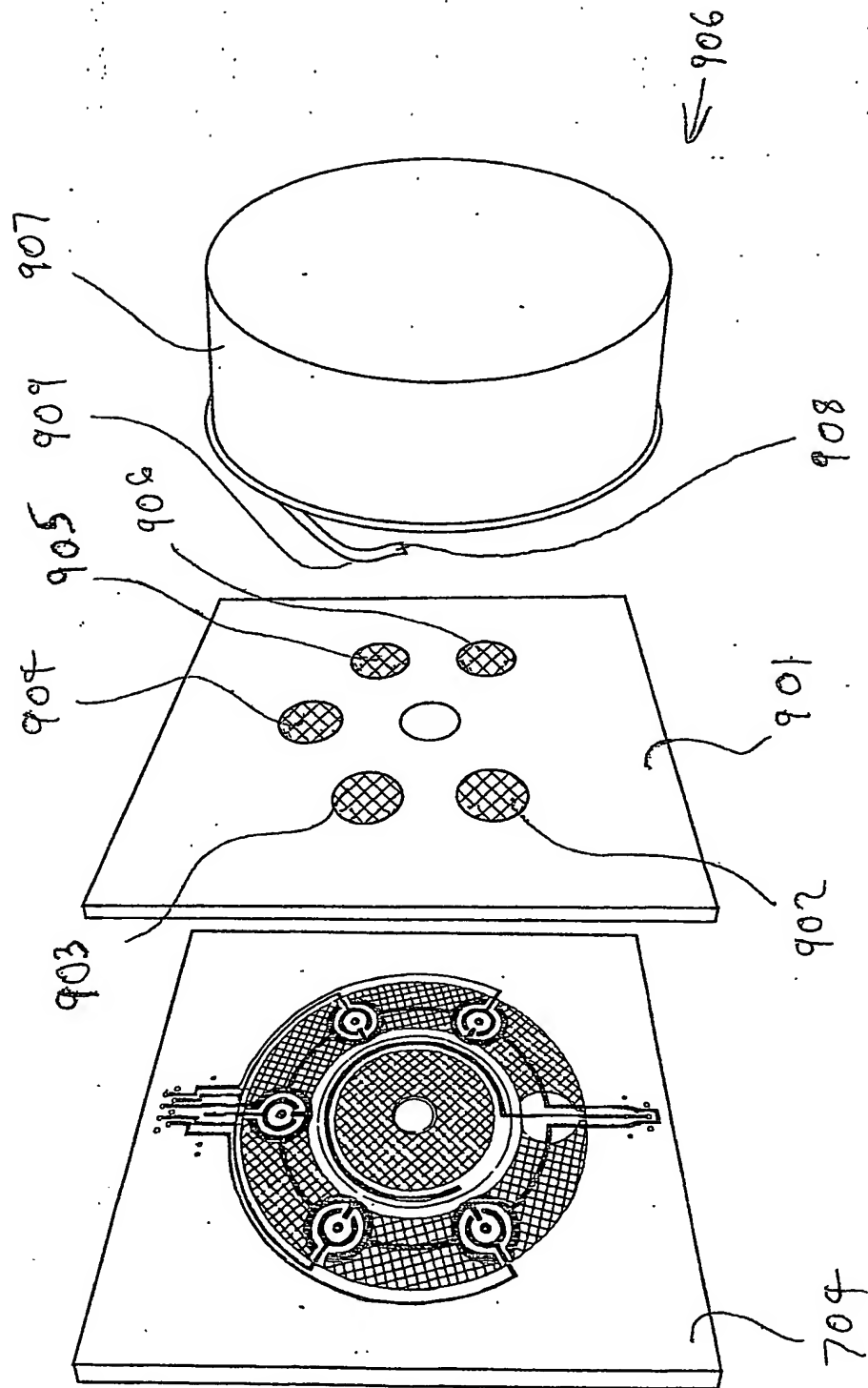


Fig. 9

10/15

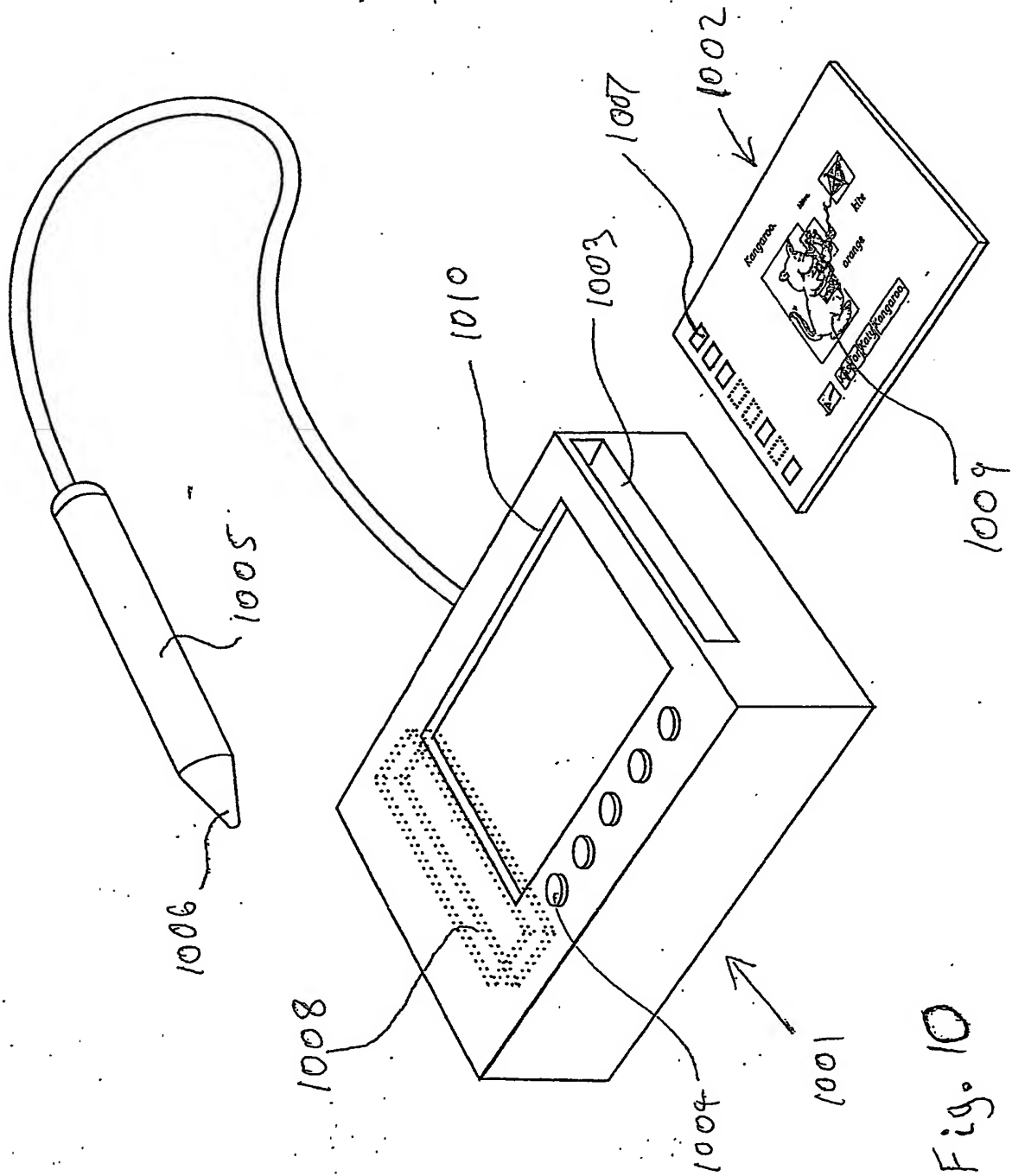


Fig. 10

11/15

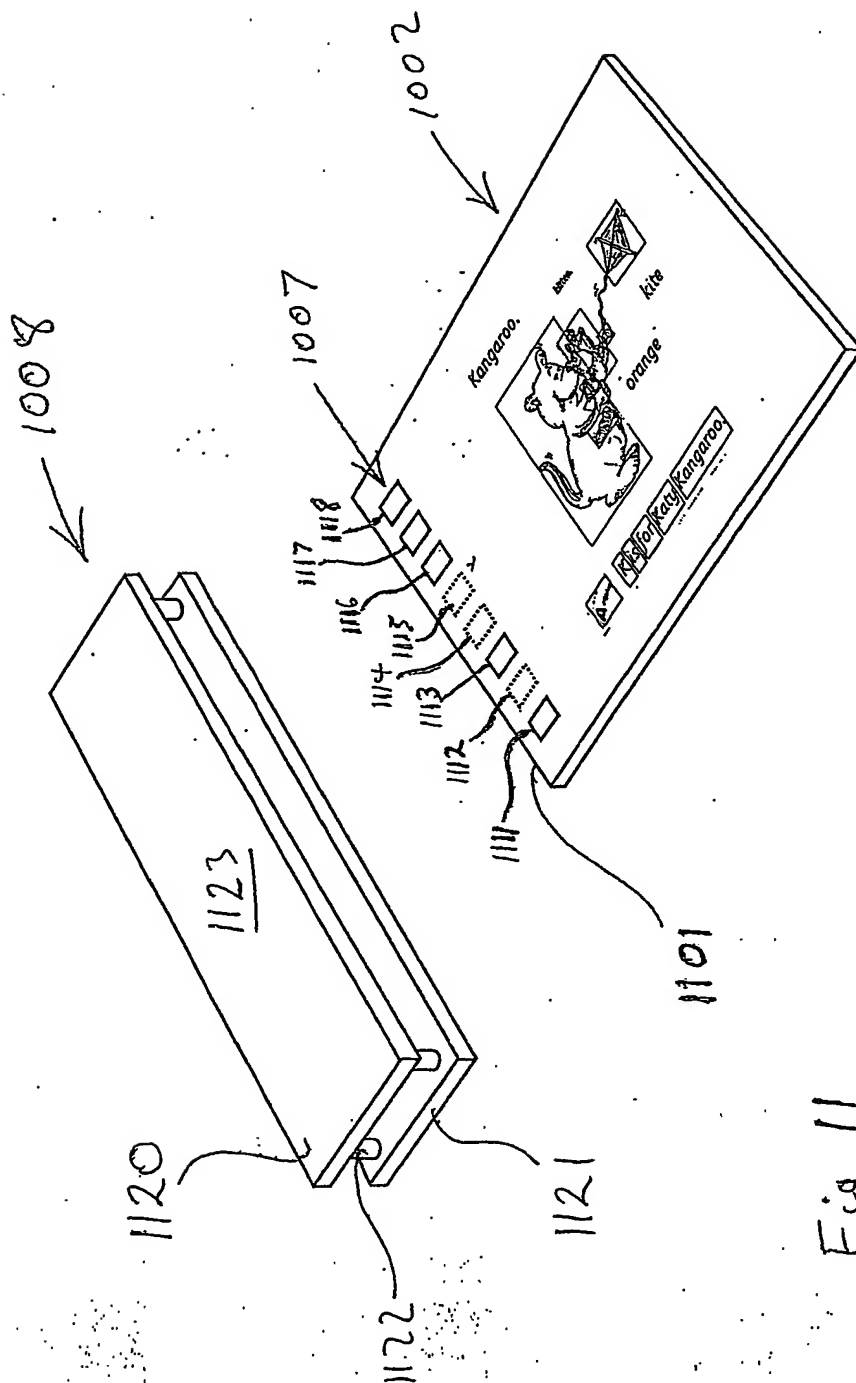
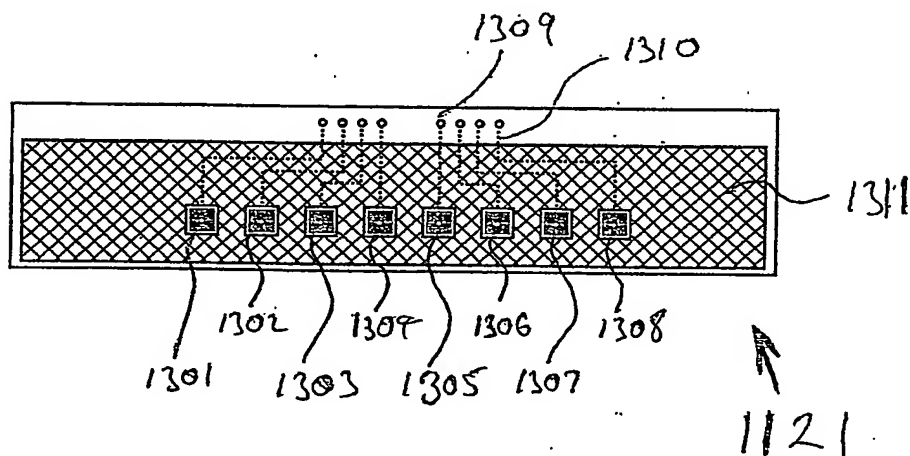
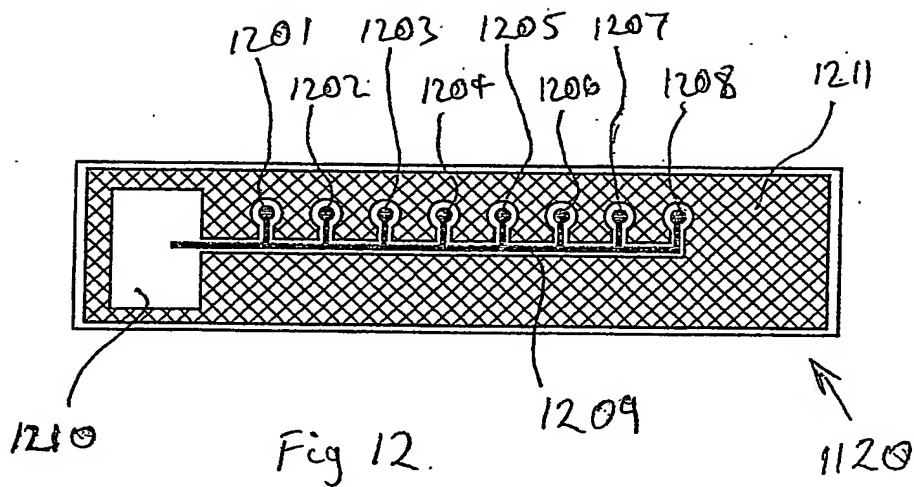


Fig. 11.

12/15



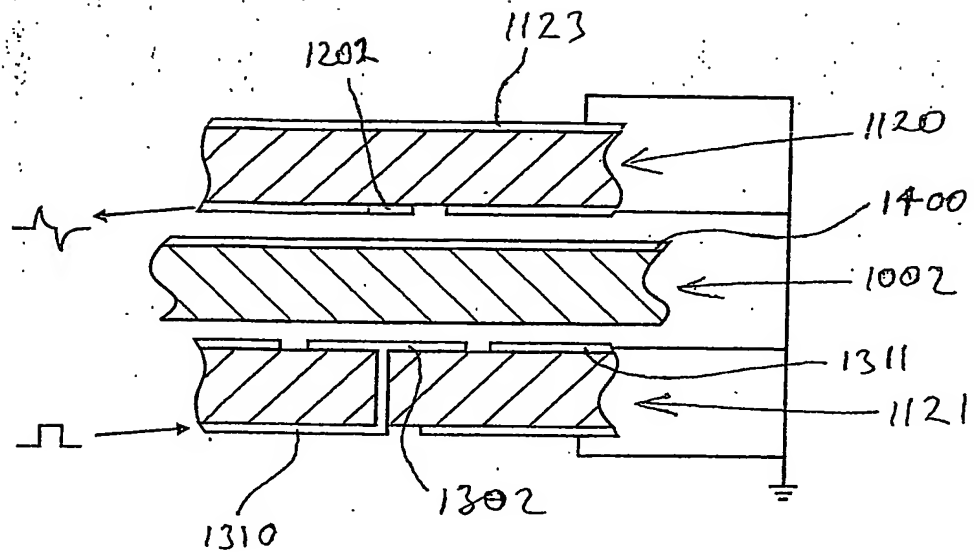


Fig. 14A

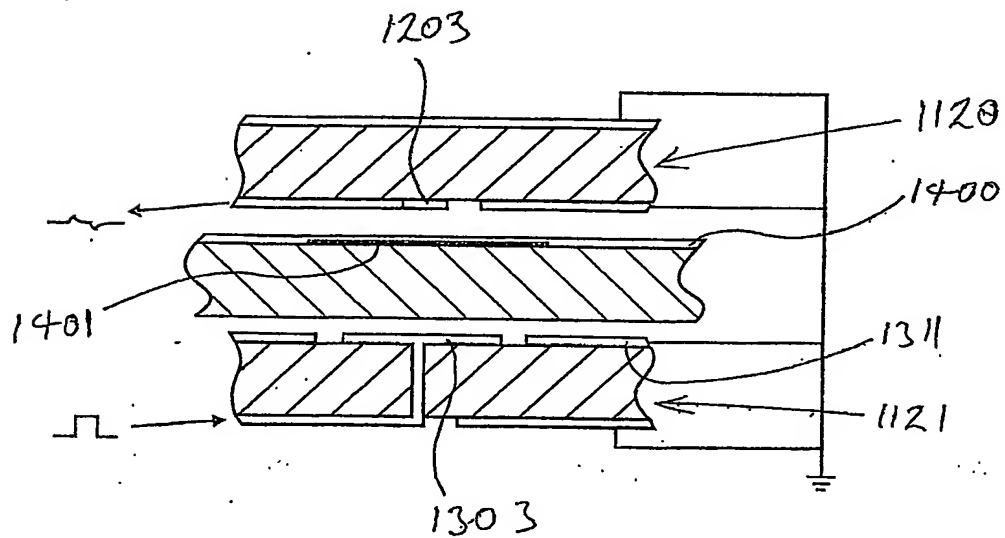


Fig. 14B

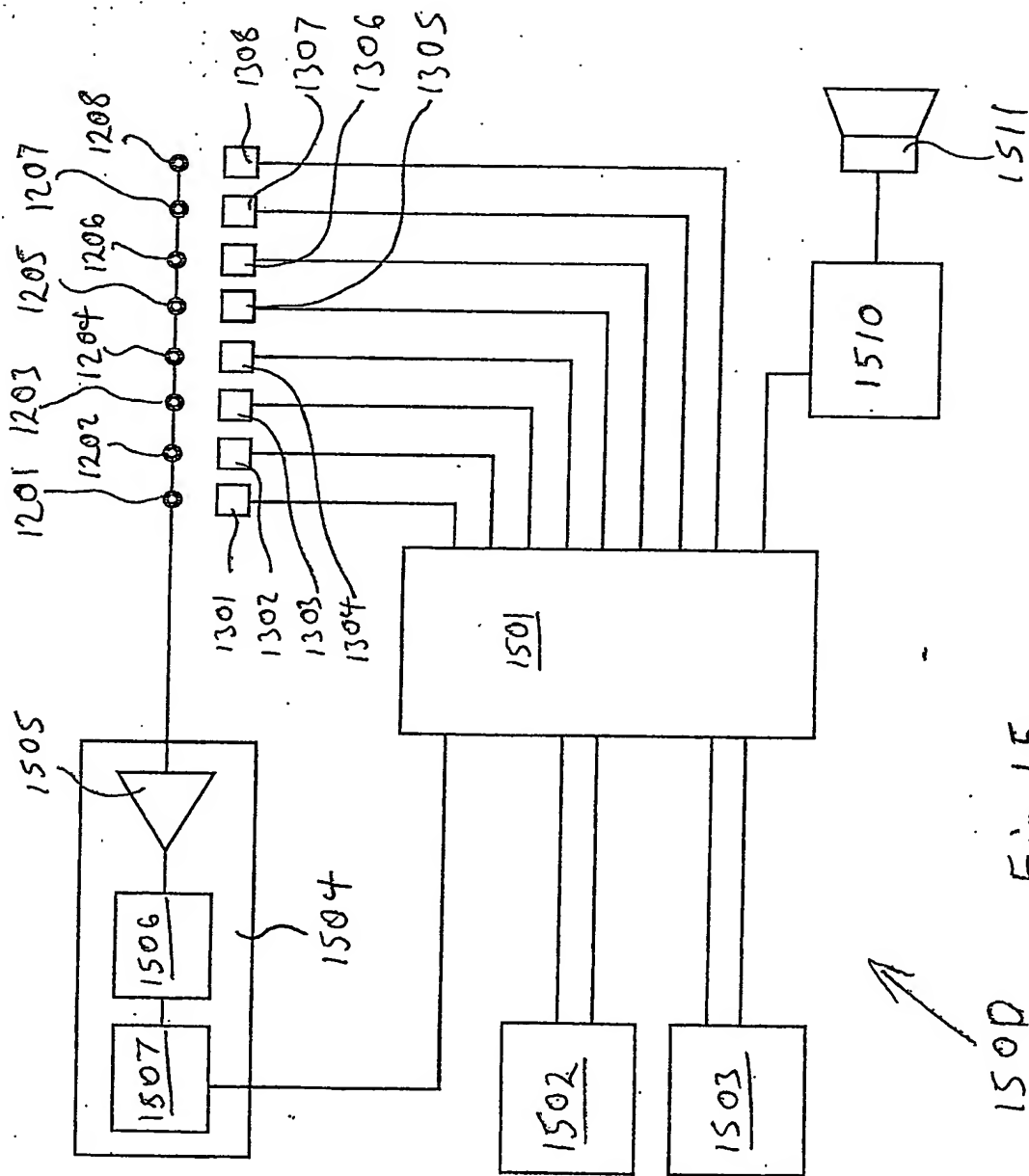


Fig. 15



1500

15/15

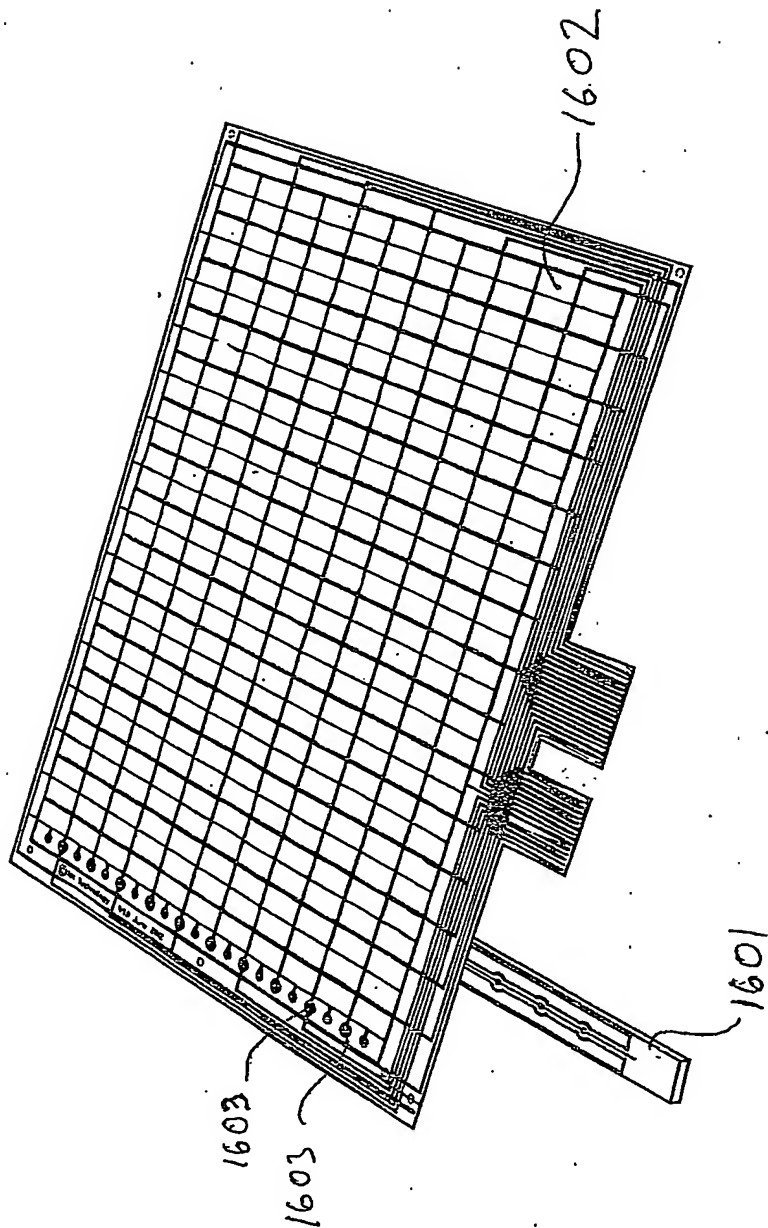


Fig. 16.

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